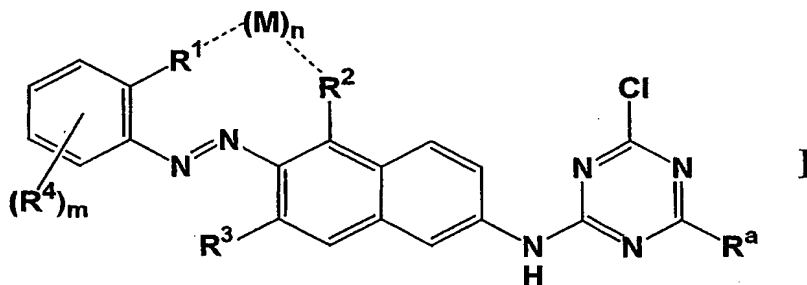


Claims

What is claimed is:

1. A method of visualizing a protein bound to a protein-binding membrane, said method comprising:

- (1) providing at least one protein bound to a protein-binding membrane;
- (2) staining said protein with an effective amount of a staining reagent comprising at least one compound of formula I:



wherein,

R^a is selected from halogen and $-NH-Ar$;

R^1 and R^3 are independently selected from the group consisting of $-OH$, $-COOH$ and $-SO_3H$;

R^2 is selected from the group consisting of $-OH$ and $-SH$;

R^4 is selected from the group consisting of $-COOH$, $-SO_3H$, $-NH_2$, $-NH(C_1-C_6)alkyl$, $-NHacyl$, $-NHAr$, $-OH$ and $-O-acyl$;

m is 0 or 1

M is a transition metal selected from the group consisting of chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium and combinations thereof;

n is 0 or 1;

----- indicates coordination to the transition metal M ; and

Ar is unsubstituted phenyl or substituted phenyl;

wherein the substituents for Ar are selected from the group consisting halogen, $-NO_2$, and $-SO_3H$;

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or a salt of such a compound;

(3) incubating said protein bound to the protein-binding membrane with said staining reagent for a time interval sufficient to allow reaction of the protein with the staining reagent to yield a stained protein;

(4) removing said staining reagent from the protein-binding membrane;
and

(5) observing the stained protein.

2. The method of claim 1 wherein:

R^a is halogen;

R^1 is $-\text{COOH}$;

R^2 is $-\text{OH}$;

R^3 is $-\text{SO}_3\text{H}$;

m is 0;

M is chromium; and

n is 0 or 1;

or a salt of such a compound.

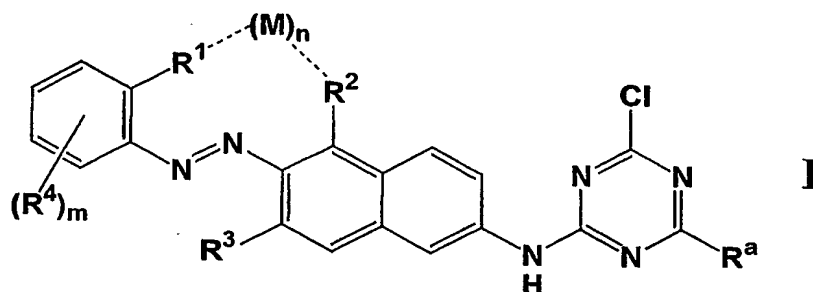
3. The method of claim 2 wherein the staining reagent comprises reactive brown 10, or a salt thereof.

4. The method of claim 1, wherein the protein-binding membrane is selected from the group consisting of nitrocellulose, nylon and polyvinylidene difluoride.

5. The method of claim 1 wherein the process is performed at room temperature.

6. A composition comprising at least one protein bound to a protein-binding membrane, which protein has been stained with a staining reagent comprising at least one compound of formula I:

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wherein,

R^a is selected from halogen and $-NH-Ar$;

R^1 and R^3 are independently selected from the group consisting of $-OH$, $-COOH$ and $-SO_3H$;

R^2 is selected from the group consisting of $-OH$ and $-SH$;

R^4 is selected from the group consisting of $-COOH$, $-SO_3H$, $-NH_2$, $-NH(C_1-C_6)alkyl$, $-NHacyl$, $-NHA_r$, $-OH$ and $-O-acyl$;

m is 0 or 1

M is a transition metal selected from the group consisting of chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium and combinations thereof;

n is 0 or 1;

----- indicates coordination to the transition metal M ; and

Ar is unsubstituted phenyl or substituted phenyl;

wherein the substituents for Ar are selected from the group consisting halogen, $-NO_2$, and $-SO_3H$;

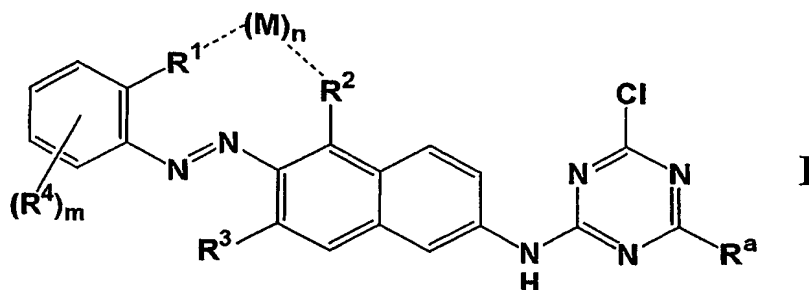
or a salt of such a compound.

7. The composition of claim 6 wherein the staining reagent comprises reactive brown 10.

8. A method of reversing the staining procedure of claim 1, comprising:

(1) providing a protein-binding membrane having at least one protein spot bound thereto stained with a staining reagent comprising at least one compound of formula I:

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wherein,

R^a is selected from halogen and $-NH-Ar$;

R^1 and R^3 are independently selected from the group consisting of $-OH$, $-COOH$ and $-SO_3H$;

R^2 is selected from the group consisting of $-OH$ and $-SH$;

R^4 is selected from the group consisting of $-COOH$, $-SO_3H$, $-NH_2$, $-NH(C_1-C_6)alkyl$, $-NHacyl$, $-NHAr$, $-OH$ and $-O-acyl$;

m is 0 or 1

M is a transition metal selected from the group consisting of chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium and combinations thereof;

n is 0 or 1;

----- indicates coordination to the transition metal M ; and

Ar is unsubstituted phenyl or substituted phenyl;

wherein the substituents for Ar are selected from the group consisting halogen, $-NO_2$, and $-SO_3H$;

or a salt of such a compound;

(2) incubating said protein-binding membrane with an aqueous alkaline solution; and

(3) washing the protein-binding membrane to remove the staining reagent.

9. The method of claim 8 wherein the staining reagent is reactive brown 10.

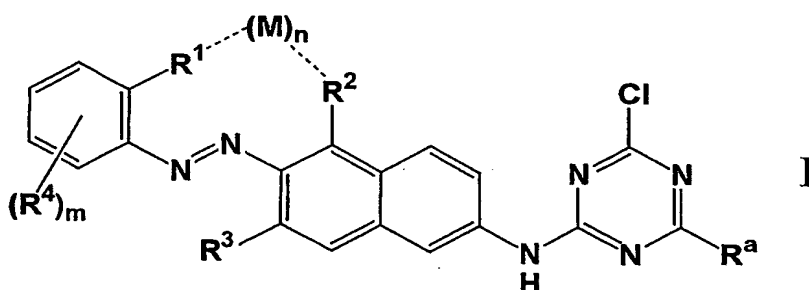
10. A method of quantifying a protein analyte, comprising:

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(1) spotting at least one protein analyte onto a protein-binding membrane to produce at least one protein analyte spot bound to the protein-binding membrane;

(2) spotting a series of known concentrations of a protein standard onto the protein-binding membrane to produce a series of protein standard spots of known quantity bound to the protein-binding membrane;

(3) staining the protein analyte spot and the protein standard spots with a staining reagent comprising at least one compound of formula I:



wherein,

R^a is selected from halogen and $-NH-Ar$;

R^1 and R^3 are independently selected from the group consisting of $-OH$, $-COOH$ and $-SO_3H$;

R^2 is selected from the group consisting of $-OH$ and $-SH$;

R^4 is selected from the group consisting of $-COOH$, $-SO_3H$, $-NH_2$, $-NH(C_1-C_6)alkyl$, $-NHacyl$, $-NHAr$, $-OH$ and $-O-acyl$;

m is 0 or 1

M is a transition metal selected from the group consisting of chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium and combinations thereof;

n is 0 or 1;

----- indicates coordination to the transition metal M ; and

Ar is unsubstituted phenyl or substituted phenyl;

wherein the substituents for Ar are selected from the group consisting halogen, $-NO_2$, and $-SO_3H$;

or a salt of such a compound;

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(4) incubating said protein analyte spot and said protein standard spots bound to the protein-binding membrane with the staining reagent for a time interval sufficient to allow reaction of the protein spot and said protein standard spots with the staining reagent;

(5) removing the staining reagent from the protein-binding membrane;

(6) generating image quantification data for the known protein standard spots and for the protein analyte spot;

(7) constructing a standard calibration curve using the known concentrations of the protein standard and the corresponding image quantification data; and

(8) calculating a concentration for the protein analyte.

11. The method of claim 10, wherein the protein-binding membrane is selected from the group consisting of nitrocellulose, nylon and polyvinylidene difluoride.

12. The method of claim 10 wherein the protein standard is bovine serum albumin.

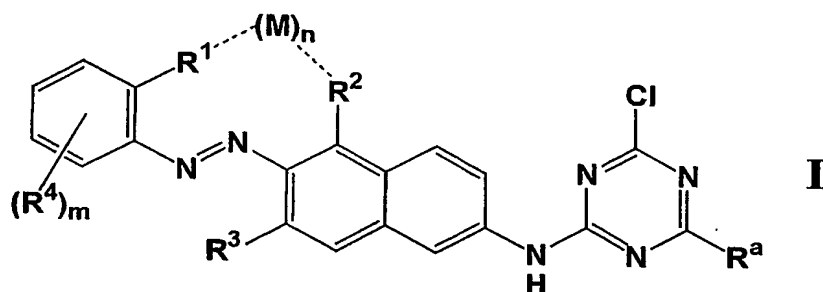
13. The method of claim 10 wherein the staining reagent comprises reactive brown 10.

14. A kit for visualizing a protein bound to a protein-binding membrane comprising:

(1) one or more protein-binding membranes; and

(2) a staining reagent comprising at least one compound of formula I:

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wherein,

R^a is selected from halogen and $-NH-Ar$;

R^1 and R^3 are independently selected from the group consisting of $-OH$, $-COOH$ and $-SO_3H$;

R^2 is selected from the group consisting of $-OH$ and $-SH$;

R^4 is selected from the group consisting of $-COOH$, $-SO_3H$, $-NH_2$, $-NH(C_1-C_6)alkyl$, $-NHacyl$, $-NHAr$, $-OH$ and $-O-acyl$;

m is 0 or 1

M is a transition metal selected from the group consisting of chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium and combinations thereof;

n is 0 or 1;

----- indicates coordination to the transition metal M ; and

Ar is unsubstituted phenyl or substituted phenyl;

wherein the substituents for Ar are selected from the group consisting halogen, $-NO_2$, and $-SO_3H$;

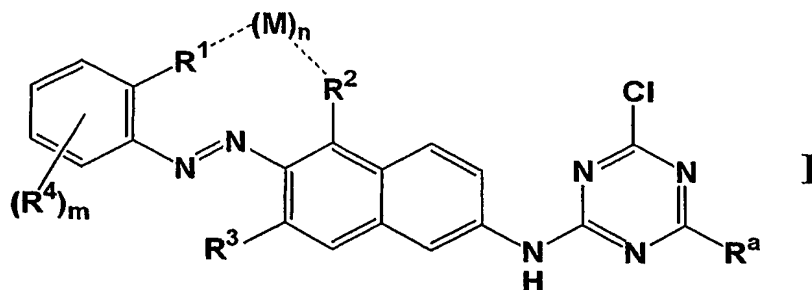
or a salt of such a compound.

15. A kit according to claim 14 wherein the staining reagent comprises reactive brown 10.

16. A kit for quantifying an amount of a protein, comprising:

- (1) one or more protein-binding membranes;
- (2) a staining reagent comprising a at least one compound of formula I:

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wherein,

R^a is selected from halogen and $-NH-Ar$;

R^1 and R^3 are independently selected from the group consisting of $-OH$, $-COOH$ and $-SO_3H$;

R^2 is selected from the group consisting of $-OH$ and $-SH$;

R^4 is selected from the group consisting of $-COOH$, $-SO_3H$, $-NH_2$, $-NH(C_1-C_6)alkyl$, $-NHacyl$, $-NHAr$, $-OH$ and $-O-acyl$;

m is 0 or 1

M is a transition metal selected from the group consisting of chromium, manganese, iron, cobalt, nickel, copper, zinc, cadmium and combinations thereof;

n is 0 or 1;

----- indicates coordination to the transition metal M ; and

Ar is unsubstituted phenyl or substituted phenyl;

wherein the substituents for Ar are selected from the group consisting halogen, $-NO_2$, and $-SO_3H$;

or a salt of such a compound; and

(3) a set of one or more solutions of a protein standard of known concentration.

17. A kit according to claim 16 wherein the staining reagent comprises reactive brown 10.